Chapter 18
Eco-Restoration for Climate Resilience and Disaster Risk Reduction

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Abstract Eco-restoration is an approach for coping with and adapting to climate change, but its results are also vulnerable to its effects. When carried out successfully and responsibly, eco-restoration helps to safeguard biodiversity, enhance human health and happiness, increase food and water security, deliver services and products, promote economic growth, and assist in climate resilience and adaptation. Moreover, it is a problem-solving strategy that involves local groups, academics, decision-makers, and land managers in order to restore ecological harm and foster better coexistence between humans and the rest of nature. Eco-restoration is the connection that is required to shift regional, national, and worldwide environmental circumstances from a state of continuing degradation to one of net improvement when paired with conservation and sustainable usage. There has never been a time when restoring degraded ecosystems was more urgently needed. In order to account for complex ecosystem functioning, this chapter discusses problems, potential strategies, and execution, particularly in relation to climate resilience and disaster risk reduction.

Keywords Eco-restoration · Climate change · Resilience · Disaster risk reduction · Disaster management

18.1 Introduction

Ecosystems are living groups of microbes, plants, and animals that interact with their surroundings in a dynamic way. Human activity has the potential to harm, deteriorate, or even destroy these communities. The loss of ecological systems, including

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forests, wetlands, marine and coastal systems, and dry lands, is a significant contributor to disaster risk and vulnerability. Due to the loss of biodiversity and ecological system services, degraded land and seascapes cost one-tenth of the world's gross product, jeopardize the well-being of 3.2 billion people—that is, 40% of the world's population—and cover over 2 billion hectares (IPBES 2018; Simonson et al. 2021).

The issues and challenges facing the planet are enormous. The COVID-19 pandemic, food and water insecurity, and the climate emergency are all having negative effects on billions of people worldwide. Ecosystems are a significant resource as we tackle these problems. It is crucial to keep them safe and sustainably manage their resources. But it won't be enough to simply increase the preservation and wise usage of our surviving beautiful habitats and water resources; we also need to restore the earth's devastated ecological systems and the enormous advantages they give (Goyal and Ojha 2010, 2012; UNEP 2021).

Eco-restoration is becoming more widely acknowledged as a vital tool for reducing the effects of environmental disasters and climate change as well as preparing for them. Globally, restoration can assist in the transition from decades of incremental environment degradation to neutral land use and eventually to net ecological improvement (Gann et al. 2019; Das et al. 2020). The entire planet must accomplish its goal to repair at least 1 billion deteriorated acres of land over the next 10 years, an area approximately the size of China, in order to combat the triple threat of climate change, loss of biodiversity, and pollution (WMO 2021).

By 2050, it is anticipated that between 50 and 700 million people will migrate due to land deterioration, climate change, and increasing trends of natural as well as man-made disasters. Rehabilitation can address some of the primary causes of environmentally prompted population movements by lowering resource scarcity, improving revenue creation, and supporting climate resilience and disaster risk reduction (Goyal et al. 2018; IPBES 2018; Poonia et al. 2021).

For tropical and mega-diverse nations, ecological restoration still poses significant obstacles, including the requirement to develop strategies that are both economically and technically realistic as well as government regulations and management systems that can gauge effective implementation. The setting and the diagnosis of the area in relation to reference ecosystems have a significant impact on the designing, implementation, and analyzing of restoration activities (e.g., forests, savannas, grasslands, wetlands) (Bustamante et al. 2019).

18.2 Eco-Restoration for Climate Resilience

Along with other related changes like rising ocean acidification and atmospheric carbon dioxide levels, climate change has an impact on ecosystems via altering mean conditions and climate variability. At the same time, ecosystems can also help with climate change adaptation and mitigation. It is necessary to investigate and quantify the mechanisms, potential, and limitations of such natural climate change remedies.

By strengthening preparedness and reducing susceptibility to adverse weather conditions, ecosystem restoration can significantly contribute to people's ability to adapt to climate change. As part of a comprehensive adaptation plan, restoration, conservation, and sustainable management of ecosystem and biodiversity services can be combined with more conventional techniques and methods (Kapos et al. 2019). Communities can frequently benefit from the restoration of coastal ecosystems by learning how to adapt to climate risks, including sea level rise, storm surges, and related flooding. Recent data demonstrates that healthy mangroves can operate as a powerful barrier against the devastation caused by tsunamis and can lower wave heights by 5% to 30% (Spalding et al. 2014). Inland eco-restoration can also lessen climate-related risks including flooding, soil erosion, and landslides brought on by exceptionally heavy rains. Restoration of the forest on slopes slows erosion brought on by heavy rain. In a similar way, the restoration of upland forests aids in controlling the flow of water, regulating supplies through periods of both heavy precipitation and dry spells (Kapos et al. 2019).

18.3 Eco-Restoration for Disaster Risk Reduction

Natural disasters have had a devastating impact on economies, properties, livelihoods, and human lives over the past decade. Ecosystem-based Disaster Risk Reduction (Eco-DRR) is a strategy where disasters are mitigated, prevented, or buffered by systematically utilizing the regulating functions of ecological systems (such as forests, wetlands, and mangroves). Ecosystem-based solutions can offer services for reducing catastrophe risk with economic and cultural value, all of which help communities become more resilient to disasters and the effects of climate change.

Eco-DRR is the sustainable and green method to minimize the disaster and extreme weather event damages. To mitigate the disaster risks, it is important to concentrate on natural solutions (such as maintaining wetlands, forests, and floodplains and restoring mangroves to the seashore to lessen the impact of waves and storm surge and prevent flooding). Additionally, it must guarantee that both new and current infrastructure is climate resilient.

Sadly, mangroves and coastal zones have lost size and health due to deforestation, land use changes, and human activities like aquaculture and tourism. Experts already believe that this degradation plays a big role in the lethal nature of Amphan in 2020 and Yaas in 2021 cyclone consequences. The "right place, right tree" concept offers technical assistance for intelligent greening and public involvement, which can greatly aid in sustainable eco-restoration for climate resilience and DRR. Hence, a systematic and integrated approach to planning is very important for the proper participation of many different organizations, including national, local, and municipal planning bodies, departments, etc.

Simultaneously, traditional coping mechanisms and wisdom must be combined with contemporary methods. The impacts of natural and climate change-related

disasters can be lessened by combining traditional and scientific management of coastal ecosystems with mangroves and other plants that follow the triple-tier mechanism and habitat. The entire coastal zone may be made more productive and sustainable under such a management structure (Sen 2021).

Eco-Restoration and Disaster Risk Reduction at Indian Sundarbans
The Sundarban Biosphere Reserve (a world heritage site, according to UNESCO) in India (9630 sq km) is the only home of mangrove tigers and is located in the largest delta in the world. It is covered in the longest continuous mangrove forest on the planet. This region is forced to take the brunt of natural disasters, which are occurring more frequently as a result of the whims of climate change and the effects of sea level rise along the Ganges-Brahmaputra-Meghna delta. There have been steps undertaken to lessen the effects of cyclones on the socioeconomically disadvantaged population of the delta and their way of life. Eco-DRR is a common strategy used globally to reduce resource damage. Mangroves have been shown to provide significant ecosystem benefits in this situation. One of the most important of these is to act as a natural bio-shield to protect the coastline from the impacts of climate change, furies of cyclones, storm surges, and tsunami. During the COVID-19 pandemic period, between May 16–21, 2020, this zone was struck by a severe super storm, AMPHAN reaching the peak wind speed of 260 km/h. This caused enormous devastation, and according to the official report, 1200 square kilometers (i.e., or 28% of the Sundarban region) of the 4263 square kilometres of the mangrove reserve forest were badly affected. In addition to preventing 60% of earthen embankment breaches, the mangrove bio-shield acted as a wind breaker and has significantly reduced flooding (Chowdhury et al. 2021).

18.4 Solutions and Practical Applications

In order to improve climate resilience, we primarily focus on the potential and difficulties related with the practical management, restoration, and ecosystem preservation. Under the broad framework of nature-based solutions (NbS), where the backdrop is mitigation of climate change, there has been an increase in interest in the ability to save, restore, and utilize ecosystems as tools to combat climate change.

By 2050, approximately two-thirds of the planet's population will reside in cities, making them a crucial location for addressing the impacts of climate change. Cities have many characteristics that make them vulnerable to the effects of climate change, such as low plant cover, increased impermeable cover, pollution production, urban heat, growing requirements for freshwater resources, and concentration of infrastructure and population in vulnerable areas, like coastal zones, river floodplains, and deforested hillsides. Urban areas' amplification effects on climate change hazards can be reduced through eco-restoration and NbS. These strategies include

increasing the amount of vegetation and green space, building rainwater harvesting ponds and other buildings that restore natural hydrologic function, and reestablishing natural protective habitats along the coastlines.

18.5 Decade on Ecosystem Restoration

The United Nations (UN) declared the current decade (2021–2030) to be the "Decade on Ecosystem Restoration" due to the urgent need to combat the effects of climate change and human-induced ecosystem degradation. This international movement aims to stop, prevent, and reverse ecosystem damage on a global scale. The main commitment of this goal is to:

(a) Focus on solutions that allow species to thrive or reestablish where their numbers have been depleted.
(b) Model the impact of climate and land use change on genetic diversity and provide early warning signs of ecosystems in danger of collapse.
(c) Create accurate habitat maps, land use projections, and decision-support tools to inform landscape-scale restoration for biodiversity net gain, water and soil security, and poverty alleviation.

The conclusion of the UN Decade on Ecosystem Restoration and the accomplishment of emission reduction objectives in line with the Paris Climate Agreement goal to keep global warming below 2 °C should both occur in 2030 in order to prevent catastrophic climate change. Sustainable land governance, which includes restoration, is a successful method of reducing global warming (Bastin et al. 2019; Strassburg et al. 2020). However, the only ultimate approach is eco-restoration. The benefits of healthy and restored ecosystems are shown in Fig. 18.1.

Also, since 2019, the United Nations Environment Program (UNEP) and Partners for Resilience (PfR) have worked together to develop and implement scalable Eco-DRR models. They have done this by partnering with various governments and their respective communities to build their capacity and shape Eco-DRR policy interventions. Through the three main pillars of Eco-DRR—ecosystem restoration/protection, disaster risk reduction, and climate smart livelihoods—a model for scaling up community resilience has been devised (shown in Fig. 18.2). With a focus on water-related, risk-sensitive wetlands restoration and capacity building efforts, India places a higher emphasis on ecosystem restoration and protection (UNEP 2022).

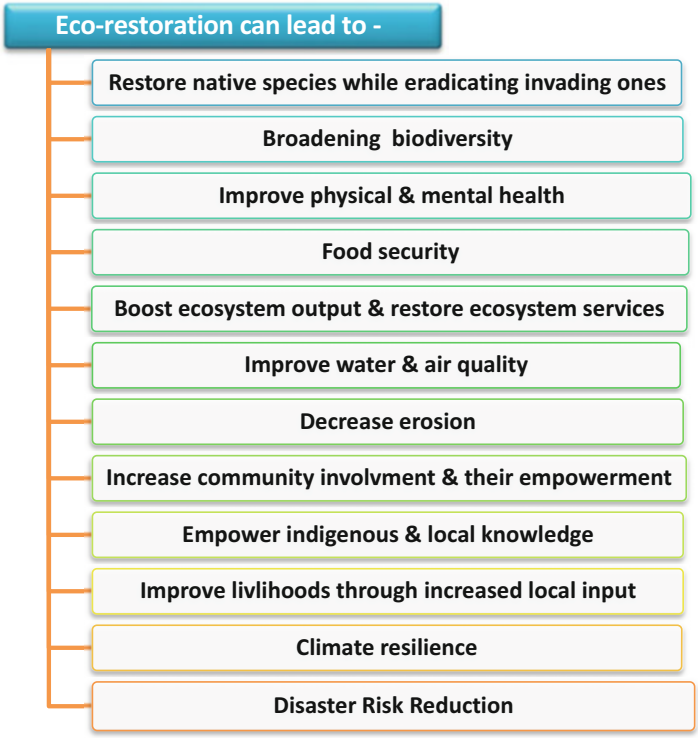

Fig. 18.1 Benefits of healthy and restored ecosystems

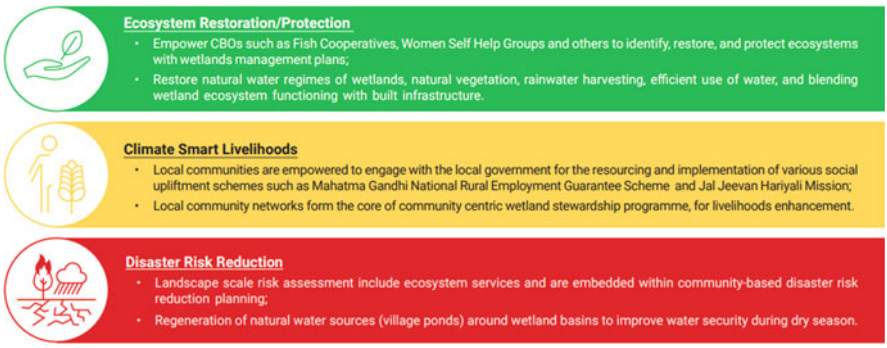

Fig. 18.2 A model devised for Eco-DRR upscaling through capacity-strengthening and the participation of communities and (local) governments (Source: UNEP 2022)

18.6 Conclusion

As a result of ongoing climate change, people and ecosystems will either have to adapt to a world that is significantly warmer than it is now or significant steps will have been taken to minimize warming within the next few decades. Eco-restoration can be a significant factor in societal adaptation and climate resilience, but it will only be beneficial if used in combination with a decline in fossil fuel emissions. In order to provide ecosystem services and mitigate climate and disaster-related risks, the integration of Eco-DRR initiatives into management plans should place sufficient emphasis on institutional structures, monitoring, and community involvement. The development of a training manual and the dissemination of Eco-DRR information to regional disaster management agencies should make it easier for them to incorporate this strategy into their planning and operations. It is also possible to lessen the effects of natural and climate change-related disasters by integrating traditional and modern scientific ecosystem management with mangroves and other vegetation that use a triple-tier mechanism and habitat.

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